Write your name here

Surname	Other names

Pearson Edexcel
Level 1/Level 2 GCSE (9 - 1)

Centre Number	Candidate Number

Physics

Paper 2

Higher Tier

Sample Assessment Material for first teaching September 2016
Time: 1 hour 45 minutes

Paper Reference
1PH0/2H

You must have:
Calculator, ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*
- Calculators may be used.
- Any diagrams may NOT be accurately drawn, unless otherwise indicated.
- You must **show all your working out** with **your answer clearly identified** at the **end of your solution**.

Information

- The total mark for this paper is 100.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- In questions marked with an asterisk (*), marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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S 5 0 0 5 2 A 0 1 4 0

PEARSON

Answer ALL questions. Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒.
If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Figure 1 shows part of a roller coaster ride seen from the side.

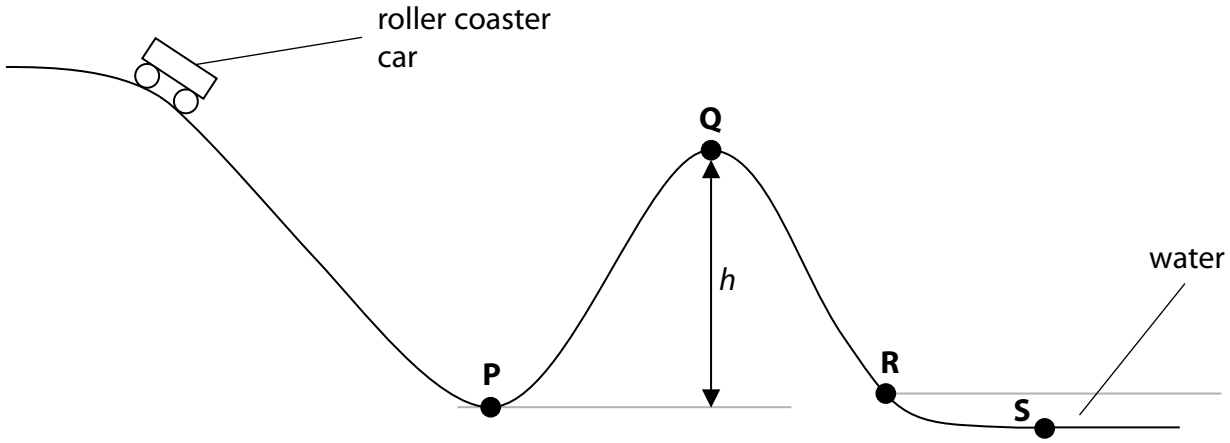

Figure 1

(a) The roller coaster car rolls down towards **P**. The car has mass, *m* kg and velocity *v* m/s.

Which of these is the correct equation for calculating the kinetic energy of the car?

(1)

☒ **A** $KE = mv$

☒ **B** $KE = mv^2$

☒ **C** $KE = ½mv^2$

☒ **D** $KE = 2mv^2$

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(b) The mass of the car is 580 kg.

The car gains 39 000 J of gravitational potential energy as it climbs from **P** to **Q**.

(i) State the equation relating change in gravitational potential energy, mass, gravitational field strength and change in vertical height.

(1)

(ii) Calculate the height *h*, shown in Figure 1.

(gravitational field strength, g = 10 N/kg)

(3)

h = ... m

(c) The car enters a pool of water at **R**. It slows down and stops at **S**.

Describe how the total energy of the system is conserved as the car travels between **R** and **S**.

(2)

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(Total for Question 1 = 7 marks)

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2 (a) Figure 2 shows a tank for holding water.

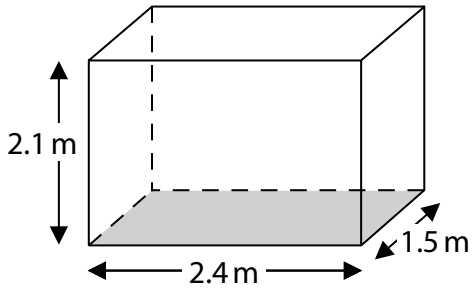


Figure 2

The tank has sides of 2.4 m, 2.1 m and 1.5 m.

The pressure at the bottom of the tank is 12 kPa.

(i) State the equation relating pressure, force and area.

(1)

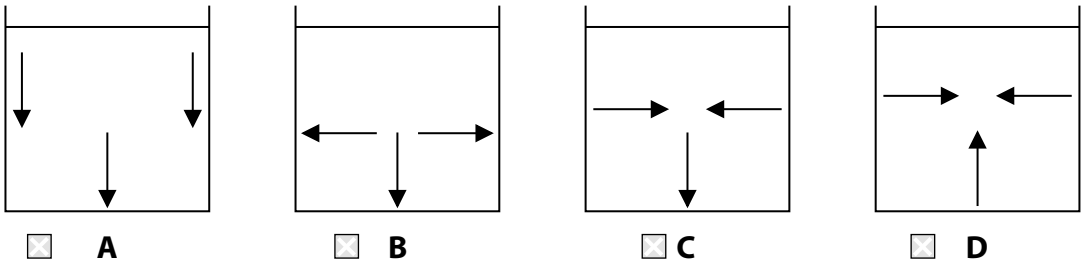
(ii) Calculate the weight of water in the tank.

(4)

weight = ... N

(iii) Which diagram shows the direction of the forces from the water on the inside of the tank?

(1)



☒ **A** ☒ **B** ☒ **C** ☒ **D**

(b) Figure 3 shows three containers A, B, and C.

Each container contains a liquid, as shown.

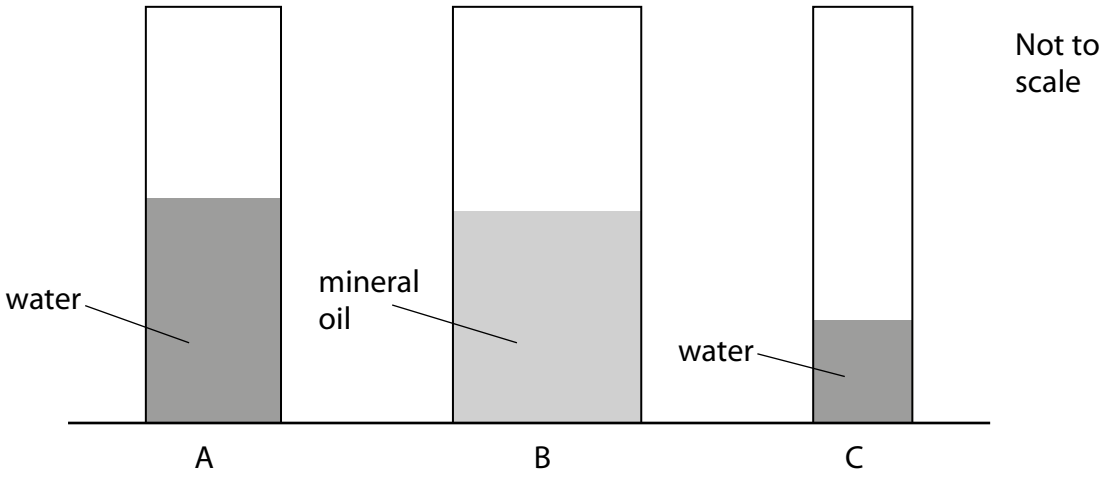


Figure 3

Figure 4 gives some data about the liquids and containers.

container	area of base (cm^2)	name of liquid	density of liquid (g/cm^3)	depth of liquid in container (cm)
A	16	water	1.00	50.00
B	32	mineral oil	0.91	50.00
C	12	water	1.00	25.00

Figure 4

Explain which container has the highest pressure at the bottom, and which container has the lowest.

Use information from Figure 3 and Figure 4.

(3)

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(Total for Question 2 = 9 marks)

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3 A student investigates how the resistance of a thermistor varies with temperature.

(a) The student sets up the circuit shown in Figure 5 to measure current and voltage.

He finds that it does not work.

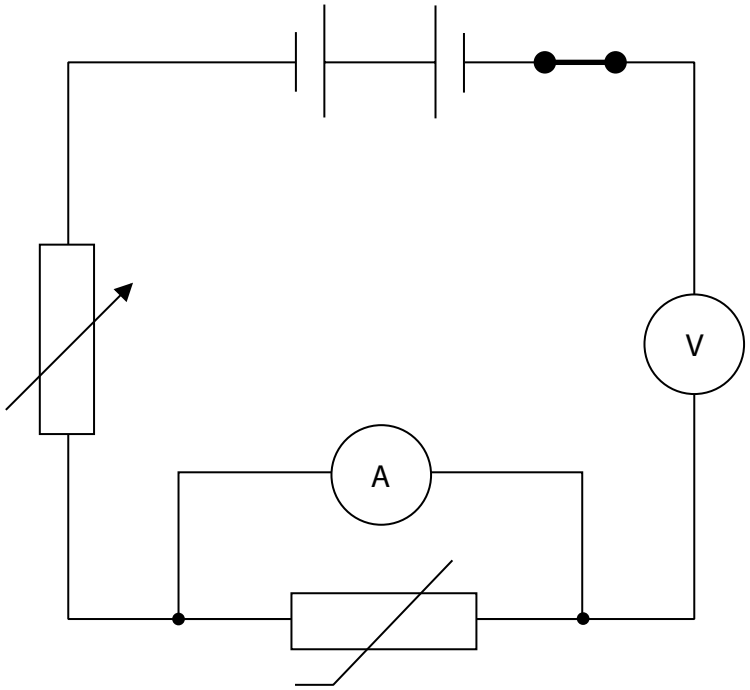

Figure 5

Give **three** modifications the student should make to the circuit so that the circuit works correctly.

(3)

1 .....

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2 .....

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3 .....

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(b) The student uses the equipment shown in Figure 6 to measure the temperature of the thermistor.

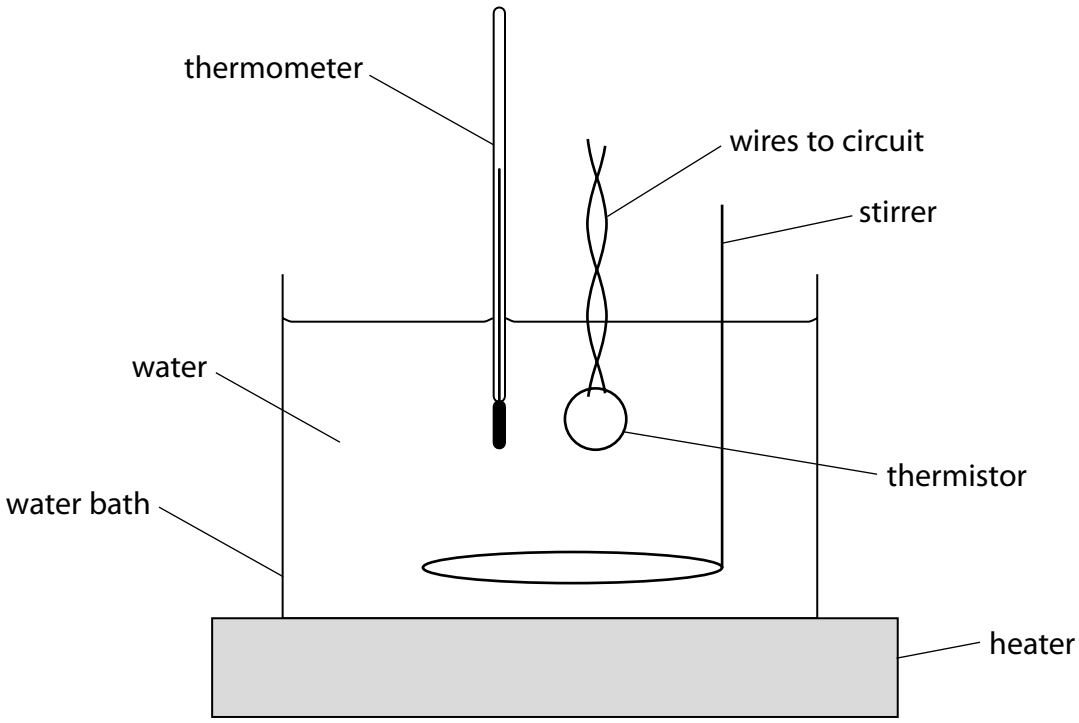

Figure 6

(i) Give **one** reason for using the water bath.

(1)

.....

.....

(ii) The equipment shown in Figure 6 is for investigations in the temperature range from 20 °C to 100 °C.

State **one** way the student could develop this experimental procedure to investigate temperatures outside this range.

(1)

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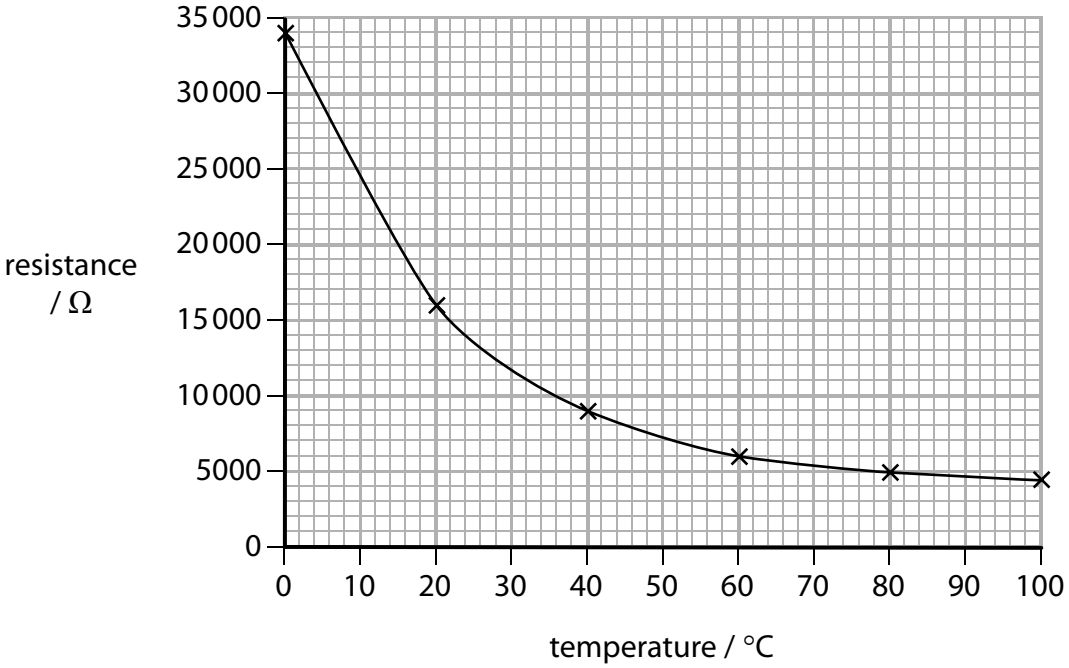
(c) The student takes measurements for two other components, **A** and **B**.

The results for both these components are shown in Figure 7.

Component A



Component B

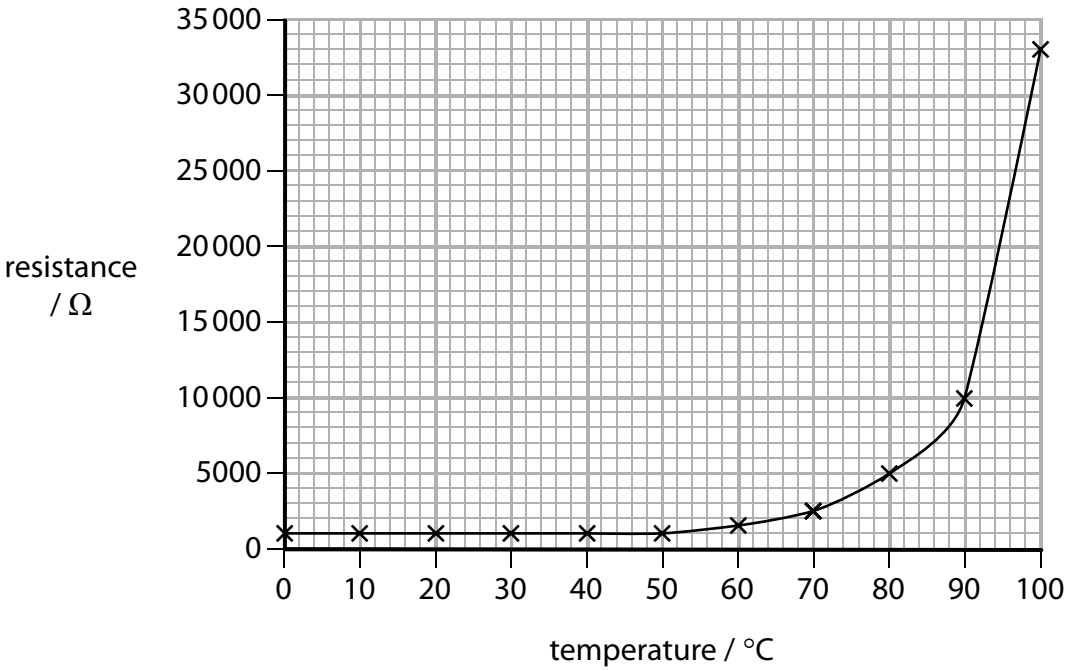


Figure 7

(i) Compare and contrast how the resistances of component **A** and component **B** vary with temperature.

(3)

(ii) Component **A** is connected to a 12V supply.

Which of these is the current in component **A** when the temperature is 80 °C?

(1)

☒ **A** $I = 12 \times 5000$

☒ **B** $I = \dfrac{12}{5000}$

☒ **C** $I = \dfrac{12^2}{5000}$

☒ **D** $I = \sqrt{\left(\dfrac{12}{5000}\right)}$

(Total for Question 3 = 9 marks)

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4 (a) Figure 8 shows an airport worker refuelling an aircraft.

(Source: © Stanisław Tokarski/123RF)

Figure 8

(i) Pumping fuel into an aircraft can be dangerous.

The worker connects an earth wire to the aircraft before pumping fuel.

Give **one** reason why earthing reduces the risk of fire.

(1)

.....

.....

(ii) Explain how an aircraft can become electrically charged as it flies through the air.

(2)

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(b) Fuel weighing 230 000 N is pumped into the aircraft.

This fuel moves upwards through a vertical height of 4.7 m.

The power developed by the pump is 1600 W.

Calculate the time needed to refuel the aircraft.

(3)

time = ... s

(c) Figure 9 shows an electrostatic method for spray-painting a car door.

The car door has a negative charge.

The droplets of paint receive a positive charge as they leave the spray gun.

(Source: © Jens Brüggemann/123RF)

Figure 9

Explain how charging the door helps the paint to form an even coating on both sides of the door.

You should use ideas of forces and fields in your answer.

(2)

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(Total for Question 4 = 8 marks)

5 A student uses a digital calliper to measure the length of a spring, as shown in Figure 10.

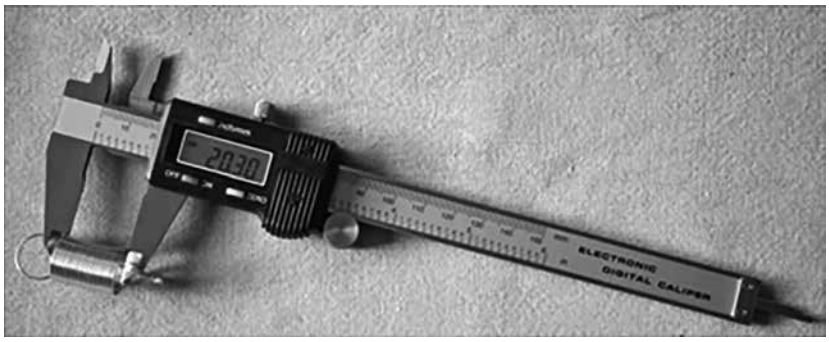


Figure 10

The spring is bendy and difficult to measure.

The student takes the six readings shown in Figure 11.

Figure 11

(a) Calculate the average length of the spring.

(2)

average length = ... mm

(b) The student investigates the stretching of a spring with the equipment shown in Figure 12.

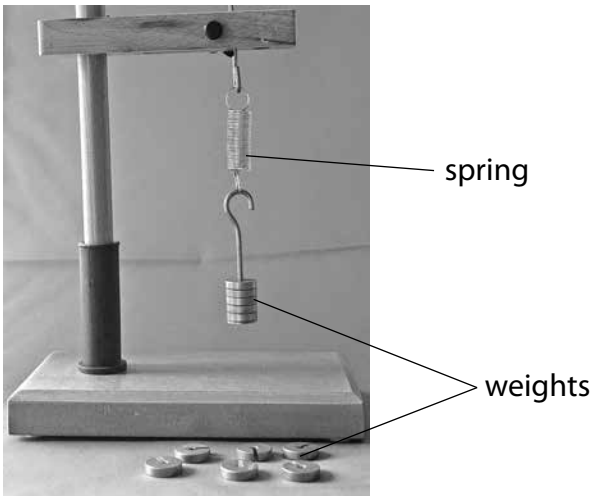


Figure 12

The student investigates the extension of the spring using six different weights.

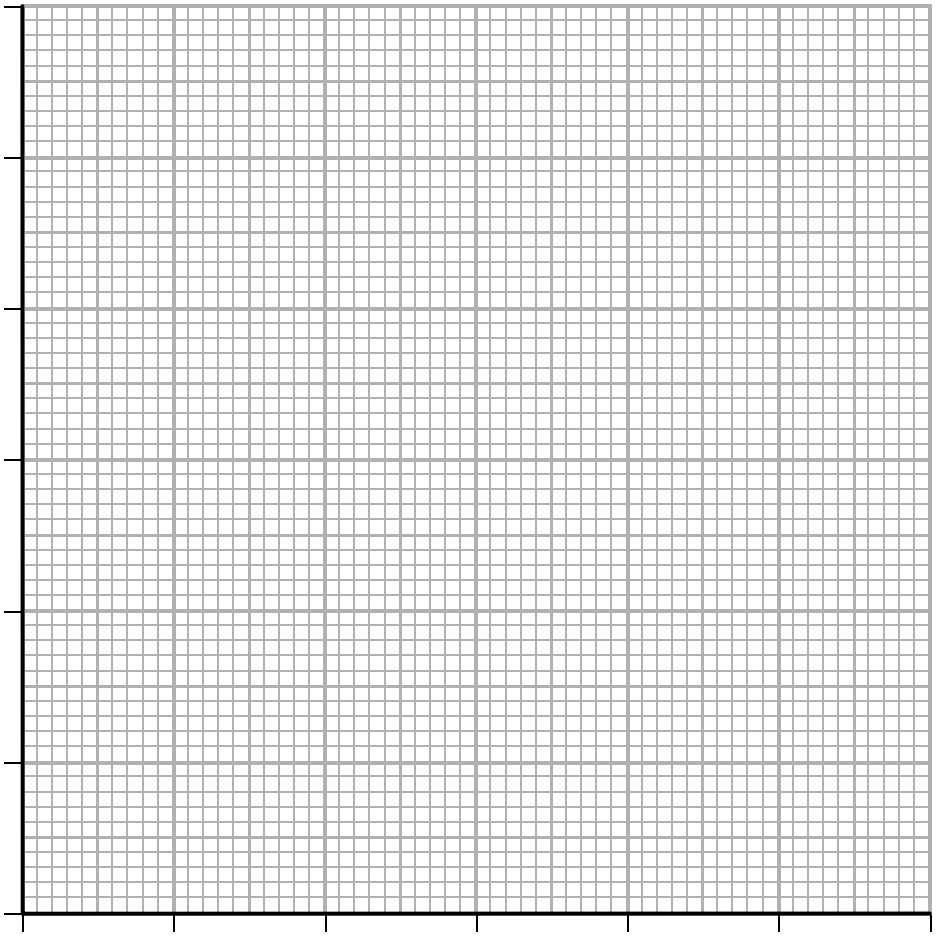
The results are shown in Figure 13.

weight (N)	extension (mm)
0.20	4.0
0.40	8.0
0.60	12.0
0.80	16.0
1.00	20.0
1.20	24.0

Figure 13

(i) Draw a graph for the readings, using the grid shown.

(3)



(ii) The student writes this conclusion:

'*The extension of the spring is directly proportional to the weight stretching the spring.*'

Comment on the student's conclusion.

(3)

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(c) The student extends the investigation by finding information about the stretching of wires.

The student finds the graph shown in Figure 14 for the stretching of a wire.

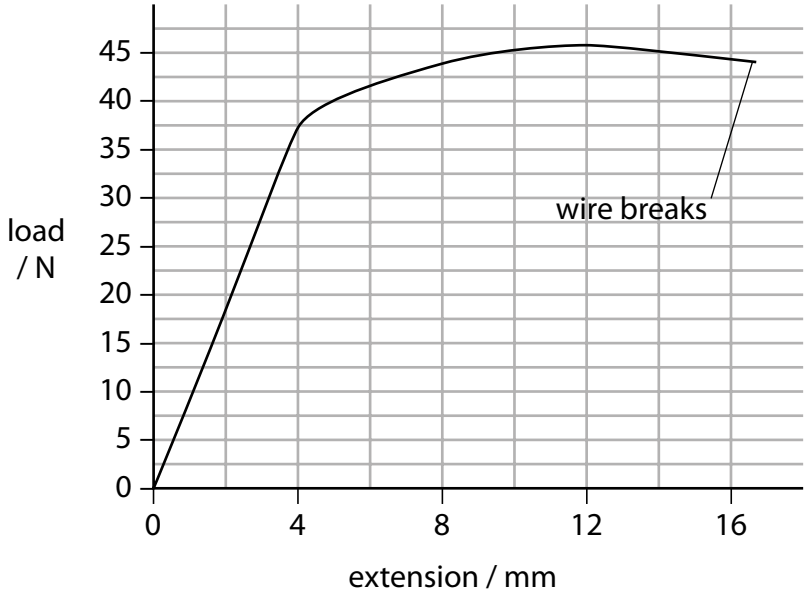

Figure 14

Describe the non-linear stretching of the wire shown in Figure 14.

(3)

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(Total for Question 5 = 11 marks)

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6 Wooden trucks on a toy railway have permanent magnets that hold the train together.

The magnets are arranged so that an N-pole touches an S-pole between each truck, as shown in Figure 15.

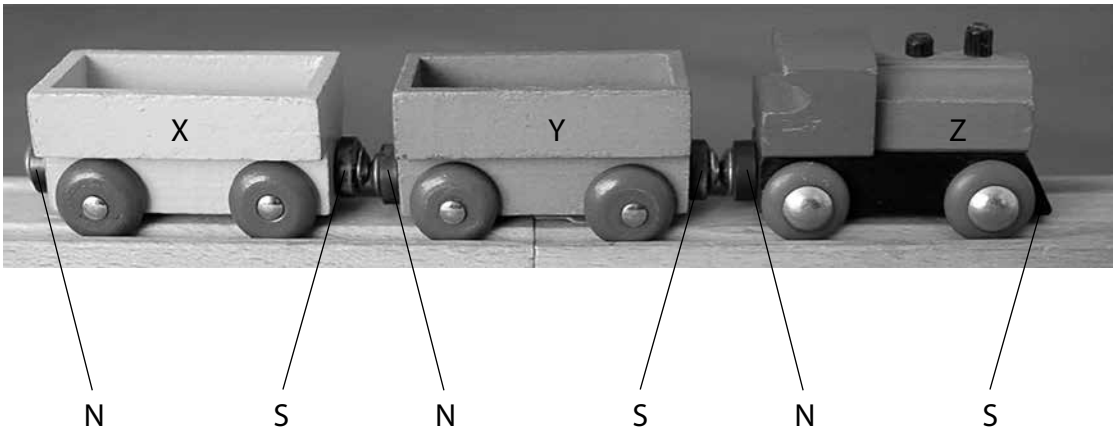


Figure 15

(a) Truck Y is removed from the train, turned through 180° and is then replaced between truck X and Z.

How does this affect the train?

(1)

☒ **A** Y attracts both X and Z as before

☒ **B** Y still attracts X but now repels Z

☒ **C** Y still attracts Z but now repels X

☒ **D** Y now repels both X and Z

(b) The structure of a truck, seen from above, is shown in Figure 16.

The permanent magnets cause a magnetic field both inside and outside the truck.

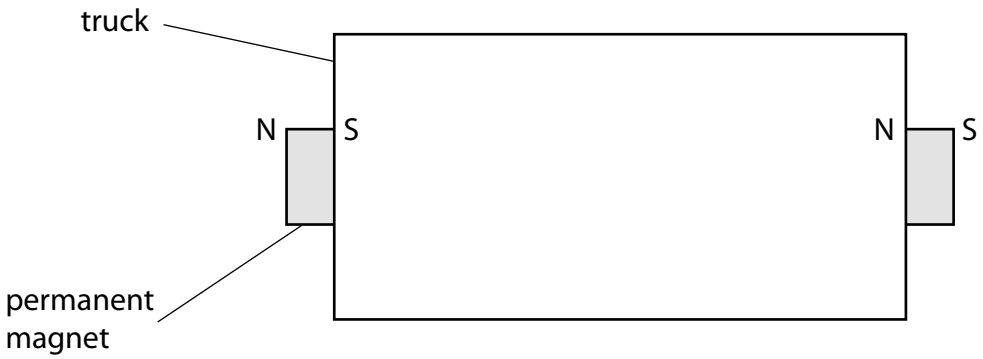
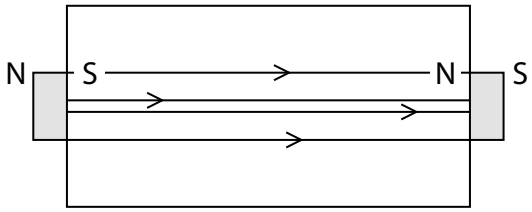


Figure 16

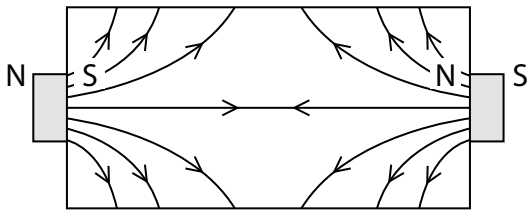
Which of these correctly shows the field inside the truck?

(1)

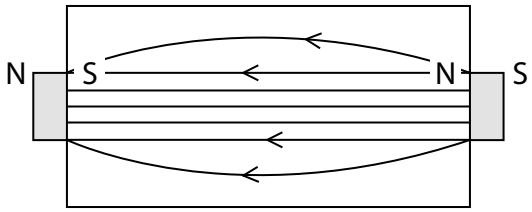
☒ **A**



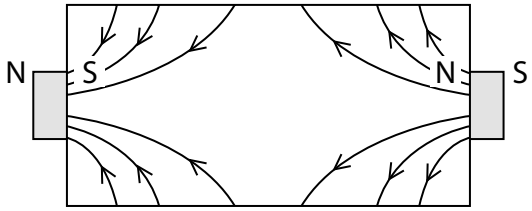
☒ **B**



☒ **C**



☒ **D**



(c) A student investigates the forces between the trucks in the toy railway.

She places another truck, **W**, next to truck **X**.

She pulls truck **Z** in the direction shown by the arrow.

The whole train travels at a constant speed as shown in Figure 17.

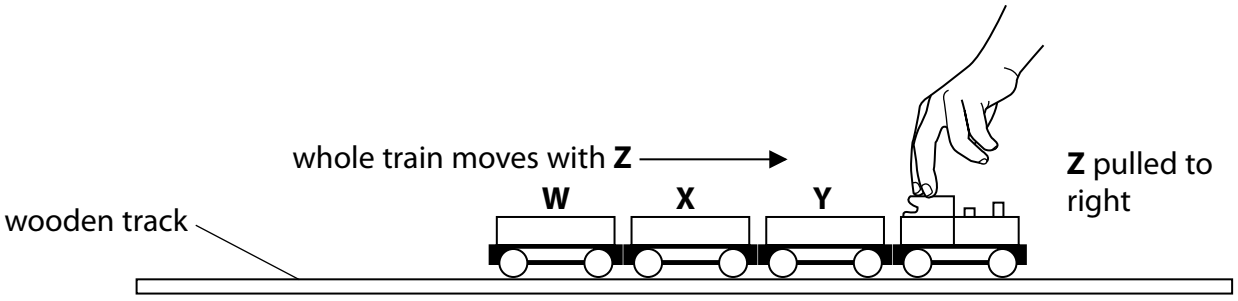


Figure 17

The student repeats this method of adding trucks and pulling the train each time.

When there are seven trucks in total, the train comes apart between **Y** and **Z** when tested as shown in Figure 18.

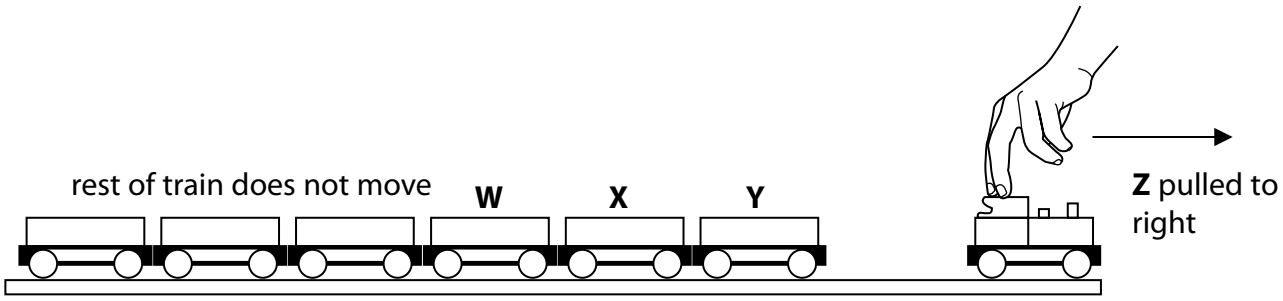


Figure 18

(i) Explain why the train acts in this way by considering the forces involved.

(2)

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.....

(ii) Devise an experiment to investigate the horizontal force needed to separate the trucks from the engine.

(3)

(iii) Explain why a larger force is needed to separate the trucks from the engine if the force is applied at an angle to the horizontal.

(2)

(Total for Question 6 = 9 marks)

7 (a) A straight piece of wire is 0.713 m long.

It is placed at right angles to a uniform magnetic field of 0.47 T.

The force on the wire is 0.089 N.

Calculate the current in the wire.

Use an equation from the formula sheet. Give your answer to an appropriate number of significant figures.

(2)

current = ... A

(b) A student investigates the relationship between the magnetic flux density and the electromagnetic force on a current-carrying wire.

The student has the equipment shown in Figure 19.

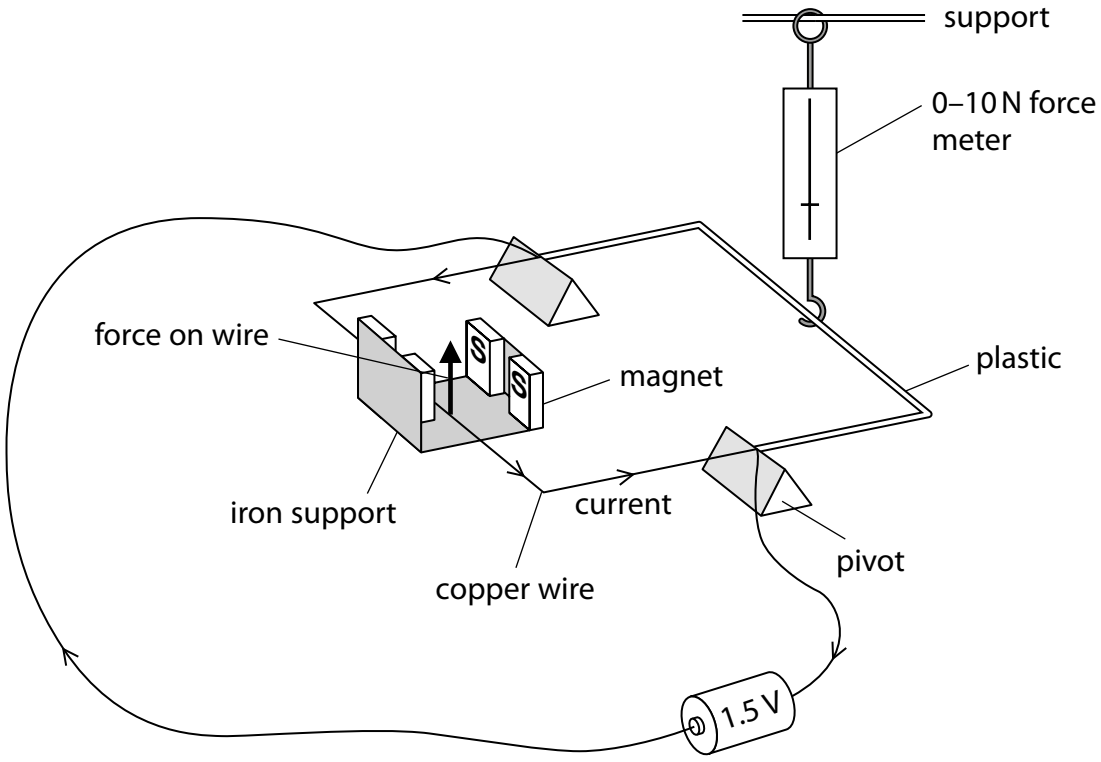

Figure 19

The student varies the number of magnets and measures the force on the wire using the force meter.

The results are shown in Figure 20.

number of pairs of magnets	reading on force meter (N)
1	0.0
2	0.0
3	0.1

Figure 20

The student decides that his equipment is not sufficiently sensitive.

Give **three** ways the student should develop his investigation to improve the quality of his results.

(3)

1 .....

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2 .....

.....

3 .....

.....

(c) Figures 21 and 22 show different voltages that can be applied across a wire.

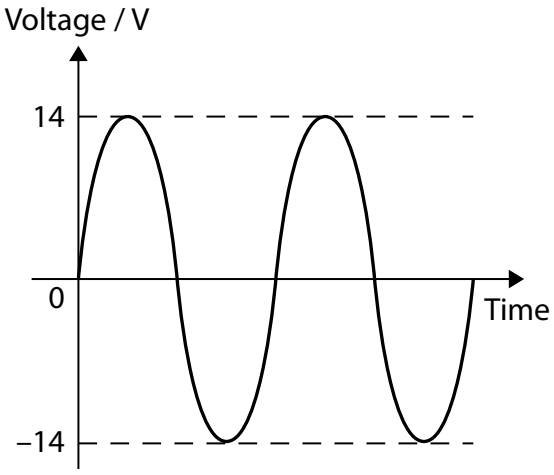

Figure 21

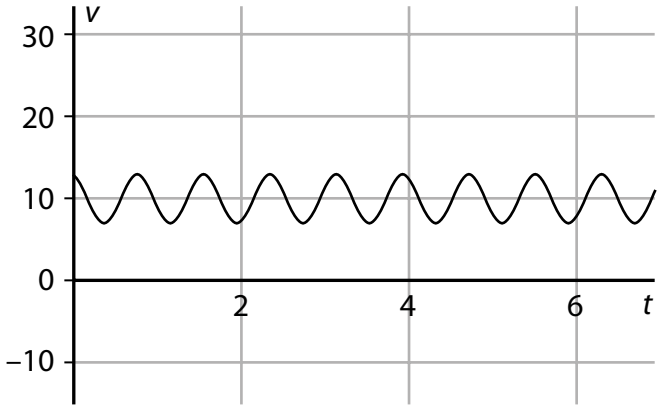

Figure 22

Explain which of the voltages in Figures 21 and 22 cause an a.c. current in the wire.

(2)

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(d) A power transmission wire hangs so that it is at right angles to the Earth's magnetic field.

Although this magnetic field is constant, the cable experiences a changing force.

Explain why the force experienced by the cable changes.

(4)

(Total for Question 7 = 11 marks)

8 Figure 23 shows an electric car connected to a battery charger.

(Source: © Danil Roudenko/123RF)

Figure 23

The car has a rechargeable battery to drive its motor.

The rechargeable battery provides a potential difference of 330 V and can store up to 64 MJ.

It takes 8 hours for the battery to receive a full charge.

Assume that the charging process is 100% efficient.

(a) Calculate the total charge that flows while the battery is being charged.

(3)

total charge = ... C

(b) Calculate the average charging current.

(3)

current = ... A

*(c) The battery charger shown in Figure 23 is connected to the 230 V a.c. domestic mains supply.

The output voltage of the charger is 335 V and it provides a d.c. charging current. Charging stops if the charging current exceeds 15 A.

Explain how electrical components in the charger can be connected together to give this type of output.

(6)

(Total for Question 8 = 12 marks)

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9 Figure 24 shows a submarine underwater.

air

water

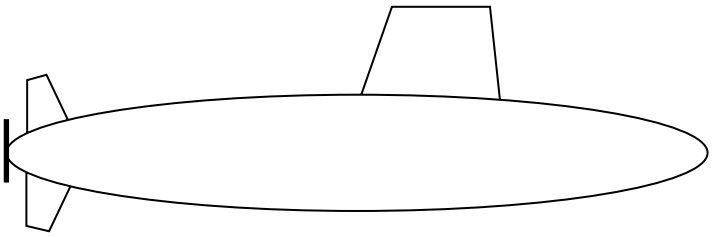

Figure 24

The motor in the submarine turns the gear wheels shown in Figure 25.

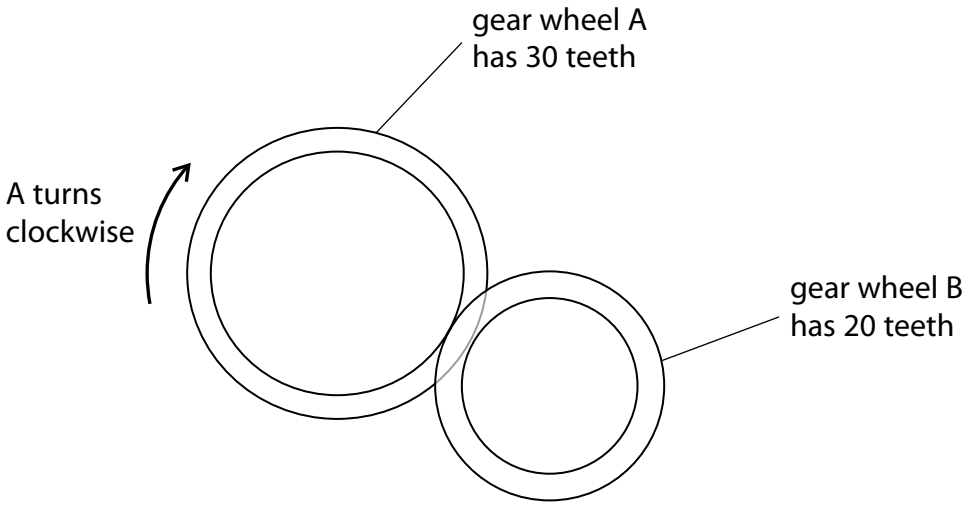

Figure 25

(a) Gear wheel A rotates clockwise through one complete turn.

Which of these is correct for gear wheel B?

(1)

	amount that gear wheel B rotates	direction gear wheel B rotates
☒ **A**	1½ turns	clockwise
☒ **B**	1½ turns	anticlockwise
☒ **C**	⅔ of a turn	clockwise
☒ **D**	⅔ of a turn	anticlockwise

(b) A bubble of gas escapes from the submarine.

The volume of the bubble is 23.0 cm^3.

The pressure of the gas inside the bubble is 297 kPa.

The bubble rises to the surface without changing temperature.

Calculate the volume of the bubble when it reaches the surface.

Atmospheric pressure = 101 kPa

Use an equation from the formula sheet.

(3)

volume = ... cm^3

(c) A student is interested in the way that submarines are controlled.

She has several regular wooden blocks, a set of weights and a tank of water.
Wood floats in water.

The student plans to immerse the wooden blocks fully in the water and investigate the relationship between the upthrust and the weight of water displaced.

Describe how she should determine **one** of the variables in this investigation.

(2)

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*(d) Figure 26 shows the submarine stationary and submerged at a depth of 10 m.

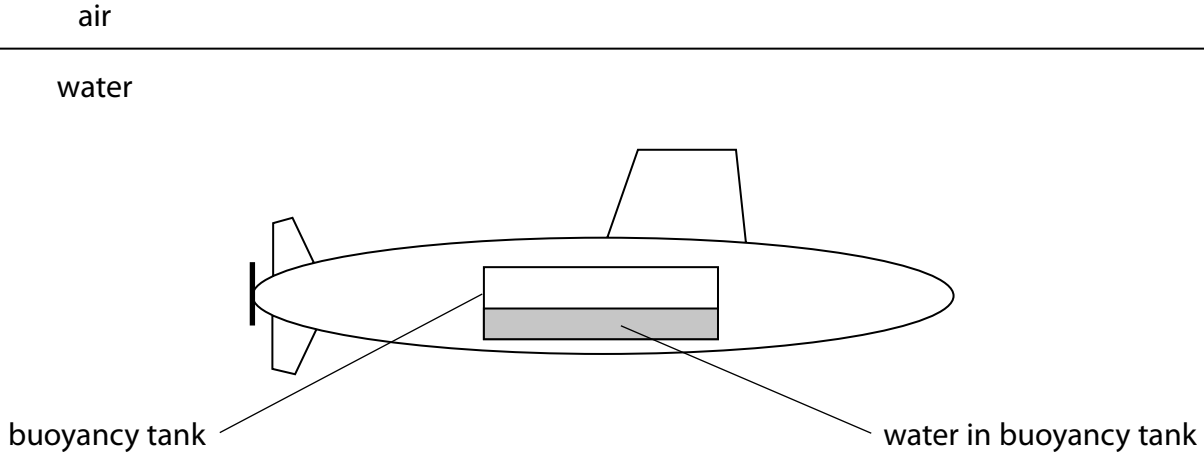

Figure 26

Explain how pumping water into and out of the buoyancy tank affects the depth of the submarine below the surface.

(6)

(Total for Question 9 = 12 marks)

10 The espresso machine shown in Figure 27 is an electrical appliance.

(Source: © tanawaty/123RF)

Figure 27

(a) The espresso machine has an electrical heater connected to a 440 V mains supply.

The power of the electrical heater is 3.5 kW.

(i) The rating of a fuse is the current above which it melts.

Which of these is the most suitable fuse for the espresso machine circuit?

(1)

☒ **A** 1 A

☒ **B** 5 A

☒ **C** 10 A

☒ **D** 13 A

(ii) Before the espresso machine can be used, its heater must raise the temperature of some cold water.

The specific heat capacity of water is 4200 J/kg K.

Show that it takes the heater about 90 s to raise the temperature of 1 kg of water from 18 °C to 95 °C.

Use an equation from the formula sheet.

(3)

(b) The espresso machine has a steam pipe that can be used to heat milk in a jug, as shown in Figure 28.

(Source: © Wavebreak Media Ltd/123RF)

Figure 28

Steam from the pipe enters the milk, where steam condenses to water.

The steam and hot water heat the milk.

(i) Describe, in terms of energy, how the arrangement and movement of particles in the steam changes as the steam enters the milk, condenses and cools.

(2)

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(ii) The specific heat capacity of milk is 3840 J/kg K.

The specific heat capacity of water is 4200 J/kg K.

The specific latent heat of condensation of steam is 2260 kJ/kg.

The temperature of the steam is 100 °C

The mass of steam that condenses is 25 g.

The temperature of the milk rises from 5 °C to 65 °C.

By considering the transfer of energy from the steam to the milk, calculate the mass of milk that is heated by the steam and hot water.

Use equations from the formula sheet.

(4)

mass of milk = ... kg

(iii) Give **two** reasons why the actual mass of steam needed to heat the milk from 5 °C to 65 °C is greater than 25 g.

(2)

1 .....

.....

2 .....

.....

(Total for Question 10 = 12 marks)

TOTAL FOR PAPER = 100 MARKS

Equations

(final velocity)^2 – (initial velocity)^2 = 2 × acceleration × distance

$v^2 - u^2 = 2 \times a \times x$

force = change in momentum ÷ time

$$F = \frac{(mv - mu)}{t}$$

energy transferred = current × potential difference × time

$E = I \times V \times t$

force on a conductor at right angles to a magnetic field carrying a current = magnetic flux density × current × length

$F = B \times I \times l$

$$\frac{\textit{voltage across primary coil}}{\textit{voltage across secondary coil}} = \frac{\textit{number of turns in primary coil}}{\textit{number of turns in secondary coil}}$$

$$\frac{V_p}{V_s} = \frac{N_p}{N_s}$$

potential difference across primary coil × current in primary coil = potential difference across secondary coil × current in secondary coil

$V_p \times I_p = V_s \times I_s$

change in thermal energy = mass × specific heat capacity × change in temperature

$\Delta Q = m \times c \times \Delta\theta$

thermal energy for a change of state = mass × specific latent heat

$Q = m \times L$

$P_1 V_1 = P_2 V_2$

to calculate pressure or volume for gases of fixed mass at constant temperature

energy transferred in stretching = 0.5 × spring constant × (extension)^2

$E = ½ \times k \times x^2$

pressure due to a column of liquid = height of column × density of liquid × gravitational field strength

$P = h \times \rho \times g$

Paper 2 Higher

Question number	Answer	Mark
1(a)	C	(1)

Question number	Answer	Mark
1(b)(i)	change in GPE = mass × gravitational field strength × change in vertical height	(1)

Question number	Answer	Additional guidance	Mark
1(b)(ii)	transformation (1) $h = \Delta E \div mg$ substitution (1) h = 39 000 ÷ (580 × 10) evaluation (1) 6.7 (m)	accept use of g = 9.81 accept 6.72 accept 6.85 (from g = 9.81)	(3)

Question number	Answer	Additional guidance	Mark
1(c)	An answer that combines the following points of application of knowledge and understanding to provide a logical description: • work is done against friction (1) • energy is stored in another specified way (1)	ignore references to friction as energy store acceptable stores are: • KE of water • thermal energy of water • thermal energy of air • (G)PE of water	(2)

Question number	Answer	Mark
2(a)(i)	pressure = force ÷ area	(1)

Question number	Answer	Additional guidance	Mark
2(a)(ii)	rearrangement (1) (F =) $P \times A$ calculation of area (1) 2.4 × 1.5 = 3.6 substitution (1) (F =) 12 000 × 3.6 answer (1) 43 200 (N)	award full marks for correct numerical answer without working maximum 3 marks if kPa not converted to Pa	**(4)**

Question number	Answer	Mark
2(a)(iii)	B	**(1)**

Question number	Answer	Additional guidance	Mark
2(b)	An explanation that combines identification via a judgement (1 mark) to reach a conclusion via justification/reasoning (2 marks): • pressure in A is the highest and pressure in C is the lowest (pressure in B is between them) (1) • pressure depends on depth of liquid (so) can compare A and C because same liquid (hence) pressure in A is twice that of C (1) • pressure depends on density of liquid (so) can compare A and B since same depth hence pressure in A greater than pressure in B (1)	allow a mathematical approach, i.e. calculating all three pressures from the relevant data	**(3)**

Question number	Answer	Additional guidance	Mark
3(a)	• connect ammeter in series (with thermistor) (1) • connect voltmeter in parallel (with thermistor) (1) • reverse (connections for) one of the cells (1)	allow idea that meters should be swapped for two marks (equivalent to first two points)	**(3)**

Question number	Answer	Additional guidance	Mark
3(b)(i)	Any one of the following reasons: • the thermistor and the water are at the same temperature (1) • large volume of water gives a steady temperature rise (1)	accept idea that only small part of thermometer would be in contact with a thermistor in air accept difficult to control change in temperature of thermistor when heated in air	**(1)**

Question number	Answer	Additional guidance	Mark
3(b)(ii)	Any one of the following developments to the procedure: • add ice to increase lower limit of temperature range (1) • use liquid with higher boiling point to increase upper limit of temperature range (1)	accept named liquid with higher boiling point, e.g. oil	**(1)**

Question number	Answer	Additional guidance	Mark
3(c)(i)	A comparison and contrast that must include at least **one** similarity and **one** difference from the following points to a maximum of three marks: Similarities • resistance of both changes with temperature (1) • both graphs show a non-linear relationship (1) • data comparison, e.g. both have the same resistance at 80°C (1)		**(3)**

	Differences • resistance of **A** decreases with temperature but resistance of **B** increases with temperature (1) • for **A**, (largest slope/rate of change) is at lower temperature but for **B**, (largest slope/rate of change) is at higher temperature(s) (1) • for **B**, resistance is constant below 50°C but for **A** resistance is roughly constant above 60°C (1)	accept (smallest slope/rate of change) for A is at higher temperature but (smallest slope/rate of change) for B is at lower temperature	

Question number	Answer	Mark
3(c)(ii)	B	**(1)**

Question number	Answer	Mark
4(a)(i)	The earth wire discharges the aircraft to prevent sparking which could ignite the fuel/cause a fire	**(1)**

Question number	Answer	Additional guidance	Mark
4(a)(ii)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (1 mark): • friction between aircraft and air (1) • causes electron transfer between aircraft and air (1)	accept idea of air rubbing against wings ignore 'charge' and 'static' do not allow (for second mark) idea of protons moving	**(2)**

Question number	Answer	Additional guidance	Mark
4(b)	Equating energy in both equations (1) E = weight × height = power × time Rearrangement (1) time = $\frac{(\text{weight} \times \text{height})}{\text{power}}$ Substitution and evaluation (1) time = 230 000 × $\frac{4.7}{1600}$ time = 680 (s)	allow answers which round to 680, e.g. 675.6	**(3)**

Question number	Answer	Mark
4(c)	An explanation that combines identification – application of knowledge (1 mark) and reasoning/justification – application of understanding (1 mark): • (negatively charged) door attracts (positively charged) paint (droplets) (1) Plus any **one** of the following: • therefore (positively charged) paint (droplets) follow lines of force and coat both sides of the car door (1) • since electric field (or lines of force) directed towards the (car) door, then positive paint will move to the door (1) • as electric field (or lines of force) touches all parts of the (car) door hence the positive paint will coat all parts of the door (1)	**(2)**

Question number	Answer	Additional guidance	Mark
5(a)	evidence that anomalous reading excluded (1) evaluation (1) average length = 20.31 (mm)	accept 101.57 (÷5) for first mark accept 20.314 (mm)	**(2)**

Question number	Answer	Additional guidance	Mark
5(b)(i)	• Axes with linear scales that use more than half of each edge of the grid and labelled with units from table (1) • All points correctly plotted to ± half a square (1) • Single straight line passing through all points and the origin (1)	allow 1 mark if only one plotting error and correct line drawn for points plotted	**(3)**

Question number	Answer	Additional guidance	Mark
5(b)(ii)	A comment that makes reference to the following points: (using table) • idea that equal increments of force/weight/mass cause equal increments of extension (1) • correct reference to figures in the table (1) OR (using graph) • the graph line is straight (1) • the graph line passes through the origin (1) AND therefore the student's conclusion is correct (1)	last marking point can only be achieved if at least one of the other two marks is awarded	**(3)**

Question number	Answer	Additional guidance	Mark
5(c)	An answer that combines points of interpretation/evaluation to provide a logical description: • above 37.5 N/4 mm there are large increases of extension for small increases in load (1) • the maximum extension of the wire is about 16.5 mm before it breaks (1) • above 12 mm the wire keeps on extending when the load is reduced below 46 N (1)	accept extension is (much) greater for each 1 N increase in load above 37.5 N	**(3)**

Question number	Answer	Mark
6(a)	D	**(1)**

Question number	Answer	Mark
6(b)	C	**(1)**

Question number	Answer	Additional guidance	Mark
6(c)(i)	An explanation that combines identification – application of knowledge (1 mark) and reasoning/justification – application of understanding (1 mark): • frictional forces increase as more trucks are added (1) Plus **one** from: • hence, in order to keep constant speed, the student must increase the force she applies to **Z** (1) • when **Y** and **Z** separate, the frictional forces (to the left) are more than magnetic attraction between **Y** and **Z** (1)		**(2)**

Question number	Answer	Mark
6(c)(ii)	An answer that combines the following points to provide a plan: • use of a Newton meter used horizontally (1) • record largest force observed (1) • repeat readings several times under same conditions (1)	**(3)**

Question number	Answer	Mark
6(c)(iii)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (1 mark): • the applied force must be resolved horizontally to determine the force that separates the engine from the trucks • and since the (size of) the resolved force is always less than the (size of) the actual force then a larger force (applied at an angle) is needed to separate the trucks from the engine	**(2)**

Question number	Answer	Additional guidance	Mark
7(a)	substitution into correctly rearranged equation (1) $I = \frac{F}{B} \times l$ $= \frac{0.089}{0.47} \times 0.713$ evaluation to 2 s.f. (1) current = 0.27 (A)	give full marks for correct numerical answer without working	**(2)**

Question number	Answer	Additional guidance	Mark
7(b)	Any three from: • use a higher current as the force depends on the current (1) • use more/stronger/larger range of magnets (1) • use a force meter with smaller range, e.g. 0.00 to 0.01 (1) • use a longer distance from pivot to increase the moment of the force on the wire (1)	accept voltage for current add variable resistor (in series) with power supply accept use more sensitive force meter	**(3)**

Question number	Answer	Mark
7(c)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (1 mark): • if the voltage changes sign, then the current is changing direction • so in Figure 21 the current is a.c. as the voltage is changing sign and in Figure 22 the current is d.c. as the voltage is always positive	**(2)**

Question number	Answer	Additional guidance	Mark
7(d)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (3 marks): • the transmission wire carries an alternating current (1) • the force is caused by this current which varies in size and direction (1) • the direction of this force depends on the direction of the current so the direction of the force also changes (1) • the magnitude of this force depends on the magnitude of the current so the magnitude of the force also changes (1)	allow responses that link the changes in the force to the interaction of the changing field around the wire with the constant field of the Earth	**(4)**

Question number	Answer	Additional guidance	Mark
8(a)	Rearrangement of equation (1) $Q = \frac{E}{V}$ Substitution including change of unit (1) 64 MJ = 64 000 000 J $Q = \frac{64\,000\,000}{330}$ Answer and unit (1) Q = 190 000 (C)	allow answers that round to 190 000, e.g. 193 939 if the calculation is worked throughout without changing MJ to J, then maximum of 2 marks unless unit matches quantity	**(3)**

Question number	Answer	Additional guidance	Mark
8(b)	Rearrangement (1) $I = \frac{Q}{t}$ Conversions and substitution (1) 190 (kC) = 190 000 (C) 8 hours = 8 × 3600 (s) = 28 800 (s) $I = \frac{190000}{28800}$ Evaluation (1) = 6.6 (A)	ecf from (a) (6.5972) if 193 939 used then accept 6.7	**(3)**

Question number	Indicative content	Mark
***8(c)**	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO1 (6 marks)** • the sequence of events is voltage change, conversion to direct current, followed by current limiting • the battery is the load in the secondary circuit, not a store of energy for the primary circuit • a transformer is needed to increase (or step up) the voltage • so a diode is needed to change a.c. to d.c. • the charging current can be limited to 15 A using a fuse (or circuit breaker) • a circuit breaker may be preferable to a fuse, since a fuse would need to be replaced after use • the transformer primary coil is connected between the live and neutral in the primary circuit • the diode is connected in the secondary circuit of the transformer • the battery(which is to be charged), diode, fuse and secondary coil should be connected in series in the secondary circuit	**(6)**

Level	Mark	Descriptor
	0	No awardable content.
Level 1	1–2	• Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Presents an explanation with some structure and coherence. (AO1)
Level 2	3–4	• Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5–6	• Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

Question number	Answer	Mark
9(a)	B	(1)

Question number	Answer	Additional guidance	Mark
9(b)	Rearrangement (1) $V_2 = (p_1 \times V_1) \div p_2$ Substitution (1) $V_2 = (297 \times 10^3 \times 23.0) \div (101 \times 10^3)$ Evaluation (1) $V_2 = 67.6\,(cm^3)$	67.633	(3)

Question number	Answer	Mark
9(c)	An answer that combines the following points to provide a logical description of the plan: EITHER • (determine upthrust) by adding weights until the block of wood is fully immersed and recording the load required (1) • calculate upthrust by adding load and weight of block (1) OR • (determine the weight of water displaced) by using a ruler to measure the dimensions of the block and multiplying them together to find the volume (1) • calculate the weight of water from volume × density × *g* (1)	(2)

Question number	Indicative content	Mark
***9(d)**	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO1 (3 marks)** • upthrust is the force on the submarine in the water (submerged) in a fluid • upthrust on the submarine and its weight act in opposite directions • upthrust is equal to the weight of water displaced by the submarine • the difference in pressures on the upper and lower surfaces of the submarine causes the upthrust **AO2 (3 marks)** • the volume of the submarine is fixed so the upthrust on the submarine is constant • increasing/decreasing volume of water in tanks increases/ decreases weight of submarine but does not affect upthrust • if weight increases to become greater than upthrust there is a resultant downward force on the submarine so the submarine sinks • if weight decreases to become less than upthrust there is a resultant upward force on the submarine so the submarine rises	**(6)**

Level	Mark	Descriptor
	0	No awardable content.
Level 1	1–2	• Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2)
Level 2	3–4	• Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2)
Level 3	5–6	• Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of

		the question. (AO2)	

Question number	Answer	Mark
10(a)(i)	C	(1)

Question number	Answer	Additional guidance	Mark
10(a)(ii)	Equating the same variable in both equations (1) $\Delta Q = m \times c \times \Delta\theta = P \times t$ Rearrangement (1) $t = \frac{(m \times c \times \Delta\theta)}{P}$ Substitution and evaluation (1) $t = \frac{(1 \times 4200 \times 77)}{3500}$ = 92 s	allow $\Delta\theta$ seen as 95 − 18 92.4 evaluation must be seen to at least 2 s.f. at some point in the working	(3)

Question number	Answer	Additional guidance	Mark
10(b)(i)	An answer that combines the following points of understanding to provide a logical description: • when steam condenses, its molecules move closer together, so the internal energy decreases (1) • when the water from the condensed steam cools, its molecules move more slowly, therefore storing less kinetic energy (1)	allow as water cools, the distance between the particles decreases which increases the intermolecular forces	(2)

Question number	Answer	Additional guidance	Mark
10(b)(ii)	equating the variables in the three equations/principle of conservation of energy (1) $(m_w \times l_w) + (m_w \times c_w \times \Delta\theta_w) = (m_m \times c_m \times \Delta\theta_m)$ rearrangement (1) $m_m = \frac{(m_w \times l_w) + (m_w \times c_w \times \Delta\theta_w)}{(c_m \times \Delta\theta_m)}$ substitution of correctly calculated quantities (1) $= \left(\frac{\left(\left(\frac{25}{1000}\right) \times 2\,260\,000\right) + \left(\left(\frac{25}{1000}\right) \times 4200 \times 35\right)}{3840 \times 60} \right)$ evaluation (1) 0.26 (kg)	allow in words or with suitable alternative subscripts temperature changes and l_w must be correct allow maximum of 3 marks for calculations that omit the energy from cooling of water	**(4)**

Question number	Answer	Mark
10(b)(iii)	Any two of the following reasons: • more steam must condense and transfer the energy that is dissipated to the jug during the process (1) • more steam must condense and transfer the energy that is dissipated to the surroundings during the process (1) • more steam must condense and transfer the energy needed to cause the milk to froth (1) • more steam must condense to replace any steam that might leave the milk without condensing (1)	**(2)**